

Reaction Rates

Given a reaction $n_A A + n_B B \rightarrow \text{products}$ that has no intermediate steps.

$$\text{Reaction Rate with respect to A} = \frac{\Delta[A]}{\Delta t}$$

$$\text{Overall Reaction Rate} = \frac{1}{n_A} \frac{\Delta[A]}{\Delta t} = \frac{1}{n_B} \frac{\Delta[B]}{\Delta t}$$

Rate Law

$$\text{Rate} = k[A]^a[B]^b$$

- ▶ a & b are usually integers, unrelated to n_A and n_B .
- ▶ a is the "order of the reaction with respect to A."
- ▶ Overall order of the reaction is the sum of the individual orders (i.e., $a + b$)

Determining Rate Order and Half-Life ($t_{1/2}$)

0th-Order (constant rate): $[A] = k[A]_0 t$

- ▶ rate = k
- ▶ Graph of $[A]$ vs t yields a straight line
- ▶ $t_{1/2} = \frac{[A]_0}{2k}$

1st-Order (exponential decay): $[A] = [A]_0 e^{-kt}$

- ▶ rate = $k[A]$
- ▶ Graph of $\ln[A]$ vs t yields a straight line
- ▶ $t_{1/2} = \frac{\ln 2}{k}$

2nd-Order: $\frac{1}{[A]} = \frac{1}{[A]_0} + kt$

- ▶ rate = $k[A]^2$
- ▶ Graph of $\frac{1}{[A]}$ vs t yields a straight line
- ▶ $t_{1/2} = \frac{1}{k[A]_0}$